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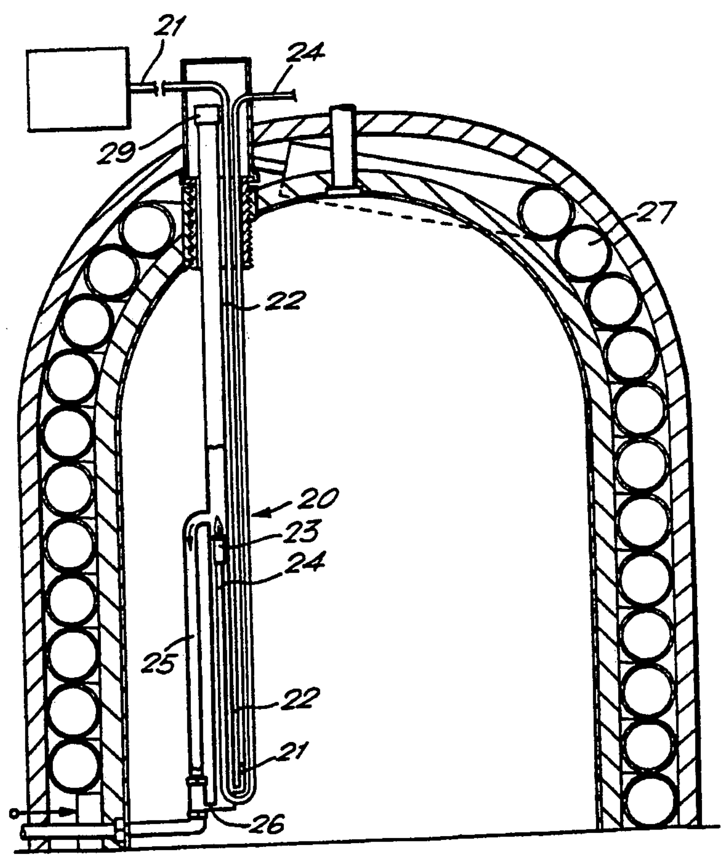
(54) Title: GAS IMMERSION HEATER

(57) Abstract

A domestic water heating system in which a cold water feed to a tank (7) forms a water (27) jacket for the tank. A heater for the tank comprises a gas burner (23) which has a combustion chamber immersed in the tank. The burner may burn continuously and the jet may be changed to meet demand. In a preferred embodiment for a consumption normally associated with a pilot flame sufficient hot water for normal use can be provided.



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GAS IMMERSION HEATER

This invention relates to heating apparatus and in particular to domestic water heaters.

Heating water for domestic purposes is presently mainly performed either by electrical immersion heaters or by circulation in pipes of heating water that is itself heated by a remote boiler. Some proposals for domestic hot water systems that utilise gas heating with a less remote flame have been made; for example, British Patent 791,727 describes a system whereby a gas flame is burnt outside, but close to, a water tank and the hot combustion gases are circulated within the tank in order to heat the water. This latter system still suffers from the heat losses incurred by burning the flame outside the tank, while the heating by a remote boiler has the known inefficencies of necessitating heating of the boiler itself and the interconnecting pipework together with their associated heat losses.

It has been proposed in PCT application WO84/01018 to completely immerse a pressurised combustion chamber within a tank. In that specification pressurised gas and air flows are used and a long exhaust is required for heat exchanging. The system does not therefore lend itself to domestic use nor make conversion of existing tanks a reasonable proposition.

The present invention is directed towards providing a heating system suitable for domestic use, utilising an immersed gas combustion chamber. A second aspect of the invention provides apparatus suitable for converting a domestic water tank to a tank heated by an immersed combustion chamber gas appliance. It is an object of the invention to eliminate much of the heat lost through inefficiencies such as thermal

cycling, burning large jets for short periods of time and indirect heating.

According to one aspect of the invention, a domestic heating system comprises a storage tank for hot water, a passageway for the supply of water to the tank, the passageway extending around the tank so as to constitute a jacket for the tank, and a gas fired heater having a combustion chamber positioned so as to be immersed in the tank.

In a preferred embodiment of the invention the capacity of the tank is effectively increased by about 50% by incorporating a water jacket between the tank inlet and the water supply. The water jacket may comprise a tube coiled around the tank and acting as both a feed water heater and a heat reservoir.

According to another aspect of the invention a domestic water heating system comprises a gas immersion heater having a combustion chamber adapted for positioning within a water tank and a jet with a cut-out control that under normal operating conditions causes the heater to burn supply gas within the combustion chamber substantially continuously.

The invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a burner according to the invention;

Figure 2 is a schematic diagram of a water tank embodying the invention; and

Figure 3 is a schematic diagram of a preferred embodiment of the invention, and

Figure 4 is a cross section through a burner assembly according to the invention.

Referring now to Figure 1 the enclosed flame burner assembly comprises a gas line 1 supplying a burner 2 which is set to burn 0.5 litres of gas per minute (at standard temperature and pressure) when on, and when turned off a 'pilot light' mode operates in which the burner burns approximately 0.2 litres of gas per minute. The line 1 and burner 2 are surrounded by an inner tube 3 which is terminated in the vicinity of the burner 2 to permit egress of combustion products. The lower end of the tube is supplied with air by an electrical or battery operated pump or fan supplying about 7 litres of air per minute. An outer tube 4 encloses the inner tube 3 and provides a barrier between the flame and the water in which the enclosed burner is to be immersed. A small quantity of condensate water collects in the passageway defined between tubes 3 and 4 and a pipe 5 is provided through which this water can be drained off.

Referring now to Figure 2, the burner assembly, shown generally as 15, extends upwards from the base of a tank 6 into which it is inserted. The tank comprises a central reservoir 7 and a plurality of communicating water jackets (three are illustrated) defined by insulating tank linings 8,9,10. Water enters the tank at the top and passes into the outermost jacket 11, travelling downwards under the influence of gravity to an opening in the outermost lining 8 where it passes into the second jacket 12 and is forced upwards by water pressure to an opening at the top of the second lining 9. The water then passes into the third jacket 13, falls by gravity to an opening in the third lining 10 and finally enters the central reservoir.

It will be seen that when water is drawn from the reservoir it will be replaced by water that is in the third water jacket 13, the water in the other jackets moving inwards and fresh water entering the outermost jacket.

In operation the burner is lit and the water heated. Because the output of the burner is low it takes longer to heat the tank from a cold start than conventional water heaters, and so a booster or conventional water heater may be used where rapid start up is required. While the water in the reservoir 7 is heating, or once it has been heated and is being maintained at an elevated temperature, heat is lost by conduction through the linings to each of the water jackets in turn. The linings 8,9,10 are made of thermally insulating material and so heat loss through these is minimised, but more importantly heat lost through the linings is absorbed by the water in the jackets and is eventually returned to the reservoir when hot water is drawn off, and the reservoir refilled by water already previously heated by the escaping heat. With conventional lagging this heat would be lost, whereas with the present invention it is recyclable.

The embodiment described in Figure 2 is highly efficient, but has the disadvantage of capital both as a prime installation or as a conversion of existing systems. A modification of the invention is shown in Figure 3, the main differences between the embodiments of Figures 2 and 3 being top insertion of the burner assembly into the tank and the replacement of the water jacket by a coil of tubing disposed around the tank and connected between the water supply and the tank water inlet. These modifications make the burner assembly easier to service and easier to install in existing tanks. Likewise the coil may be installed around existing tanks. Also shown in Figure 3 is a modification of the burner so that the flow of combusted gases follows a 'U' tube configuration rather than the concentric tube configuration of Figure 2.

The gas and air supply are both introduced to the base of the burner and the pipes conducting the gas and air are inserted through the aperture in the top of the tank. In Figure 3, the gas and air lines are shown as separate from the burner tubes, but it is possible for them to be made integral or to have clamps securing the pipes to the burner assembly. The condensate is removed from the base of the tank. A swivel connection is provided on the outlet pipe, to assist alignment: a swivel could alternatively be provided elsewhere such as on the aperture fixing on the top of the tank.

Figure 4 shows in cross section a preferred construction for the arrangement of the tubes at the tank aperture, with all the tubes retained within a single outer sleeve.

With the burner assembly according to the invention, the flame is maintained in a continually lit condition during normal operation. A thermostat safety cut-out is provided so that the gas supply is cut off in the event of overheating and a flame-out sensor is also provided to cut off the gas supply if the flame goes out due, for example, to pump failure. The described burner with two settings of 0.2 and 0.5 litres per minute consumption is intended to operate most of the time on the higher setting, the lower setting being mainly intended to provide a pilot flame but, nevertheless, providing useful heating. It will be noted that the maximum consumption (0.5 l/min) is of the same order as in the pilot mode. Thermostat controls,are provided to regulate the change from 'high' to 'low' burner setting. It is advantageous for the thermostat to be positioned in the outer water jacket, with 30 or 40 litres of water between the thermostatic sensor and the mains cold water inlet to the water jacket. Thus, as water is used, the thermostat senses the temperature drop caused by incoming cold water well in advance of the tank temperature's dropping too low, and the flame is switched to

high' (or as is more likely is prompted to remain in the 'high' mode) causing an increase in the water temperature in the tank and an increase in the water temperature in the tube. The flame is only switched to 'low' when the water in the tube reaches, for example, 50°C, when generally the water in the tank will be at about 70°C. In the event that the water in the tank exceeds a chosen safe upper temperature, say 85°C, the entire flame is cut out.

Referring in detail to Figures 3 and 4 the burner assembly is indicated generally as 20. It consists of five supply tubes preferably disposed in the arrangement of Figure 4. For the sake of clarity the lower part of Figure 3 is not drawn to scale. The assembly should in fact be capable of insertion through the tank aperture. Air is supplied via tube 21 to the base of burner tube 22 within which the burner 23 is supplied with gas via line 24. A cap 29 is provided on the top of tube 22 so that after ignition the combusted gases pass into exhaust tube 25 which bends downwardly. The heat of combustion is passed from the exhaust gases to the water and the gases are cooled substantially to the temperature of the water by the time that they pass out of the base of the tank. Condensate is drained fron the base of the burner tube via line 26. Water from the cold water supply passes initially, as indicated by the arrow, into the base of the coiled tubing 27, passes around the tank and then out of the tubing and into (not shown) the water inlet pipe 28 to the tank (see Figure 4). The water inlet pipe passes through the tank aperture and down to the base of the tank alongside the burner assembly and as shown in Figure 4 may be made an integral part of the assembly. In order to ignite the jet a piezoelectric device may be provided, and it is possible too eliminate the pilot flame mode in favour of such ignition. However the pilot flame mode is usefully incorporated into

the apparatus and piezoelectric ignition may be provided for initial starting only, or eliminated in favour of manual ignition at the top of the tube 22, from where the flame will blow back to jet 23.

The apparatus shown in Figure 3 has its overall capacity increased by the volume of the tubing, and the positioning of the thermostatic sensor in the tubing provides advance warning of the incoming cold water to the tank.

An alternative positioning for the thermostatic sensor must be found if the immersion heater is to be used in tanks without the coil of tubing or other outer water jacket. In this instance the water inlet pipe 28 supplies water to a chamber in which the sensor is located. The chamber may comprise a widened portion of tubing located within the burner assembly. This location for the sensor may also be used as an alternative to the location within the water jacket even if a water jacket is provided, the sensor being adjusted to compensate for the preheating of the feed water.

At the start of the day the heat content in the apparatus is at a maximum, the water in the tank being at 70°C and the water jacket or tubing (if any) temperature at 50°C. During the day, as water is used, the heat content drops but the water remains usably hot and then overnight the heat content is restored to a maximum. The system is intended to operate with the 'high' flame on for about 22 to 24 hours each day, substantially continuously, and various adjustments can be made to achieve this optimum condition, with the flame burning efficiently.

Firstly, if the flame tends to cut out frequently, this indicates a relatively sparing use of hot water and greater efficiency is achieved by lowering the temperature of stored water and lowering the thermostat sensor setting for both switching on and switching off the high flame. The heat

capacity of the system may be reduced by removing, reducing or not providing the tubing jacket.

If to the contrary the water is too cool for use later in the day this indicates that consumption exceeds the rate of supply of heat by too large an amount. To remedy this the overall heat content of the system at the start of the day may be raised, thus increasing the reservoir of heat: for example a tank temperature of 75°C may be set, and the thermostat sensor set to switch or maintain 'high' flame setting at a higher temperature. The size of the tubing may also be adjusted. If adequate hot water is still not produced then a larger burner may be provided, burning for example 0.7 litres of gas per minute or even up to 2 litres of gas per minute. The fan or pump provided is preferbly chosen to be adjustable to provide more air for larger jets.

The control over the thermostat for determining onset of 'high' flame and the maximum stored water temperature is available to the user and adjustments may be made in accordance with winter and summer temperatures or changes in demand. Changing the burner is a longer job and depending upon design may require drainage of the system. Thus it is generally intended that the correct jet should be selected before installation from estimated hot water consumption and changes made only to cope with perhaps an increase or decrease in the size of household or other long-term change in demand. In the preferred embodiment, the jet may be changed with the burner assembly <u>in situ</u>,and without draining the system, by removing the cap and extending a tool down the tube 22. If the jet is much larger a longer path for the combustion gases may be required and for this purpose the jet may be located closer to the base of the tank by shortening the jet end of line 24. This may be achieved by mounting the jets on tubular extensions for line 24 that connect on to the main part of line 24 close to the base. Larger jets are then provided with shorter tubular extension pieces. Fins may also

be provided on the exhaust. It will be noted that the described embodiment enables the path for the exhaust gas th be simple rather than tortuous; the use of ungainly coils is avoided and the construction and installation are simplified. Heat exchange is aided by the gases being conducted towards progressively cooler water, the cold water inlet being at the base of the tank.

CLAIMS.

1. A domestic heating system comprising a storage tank for hot water, a passageway for the supply of water to the tank, the passageway extending around the tank so as to constitute a jacket for the tank, and a gas fired heater having a combustion chamber positioned so as to be immersed in the tank.

2. A system according to claim 1 in which the passageway comprises a tube which is coiled closely around the tank.

3. A system according to claim 1 or claim 2 in which the heater has a cut-out control having a mode in which the heater burns supply gas within the combustion chamber substantially continuously.

4. A domestic water heating system comprising a gas immersion heater having a combustion chamber adapted for positioning within a water tank and a jet with a cut-out control that under normal operating conditions causes the heater to burn supply gas substantially continously.

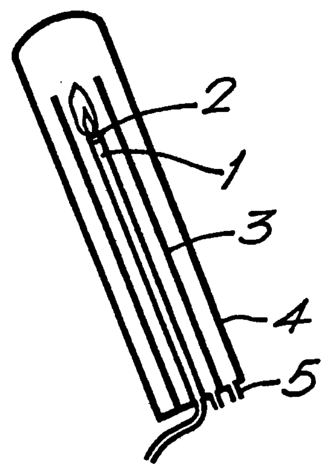
5. A domestic water heating system according to any preceding claim, comprising a jet having a pilot flame that burns within the immersed combustion chamber.

6. A domestic water heating system according to any preceding claim in which the jet is located approximately midway between the base and the top of the tank.

7. A domestic water heating system according to any preceding claim in which exhaust gases are conducted from the jet to the wall of the tank by way of a simple path.

8. A domestic water heating system according to any preceding claim in which exhaust gases are conducted from the combustion chamber via a path that passes through progressively cooler regions of the tank.

FIG.1.



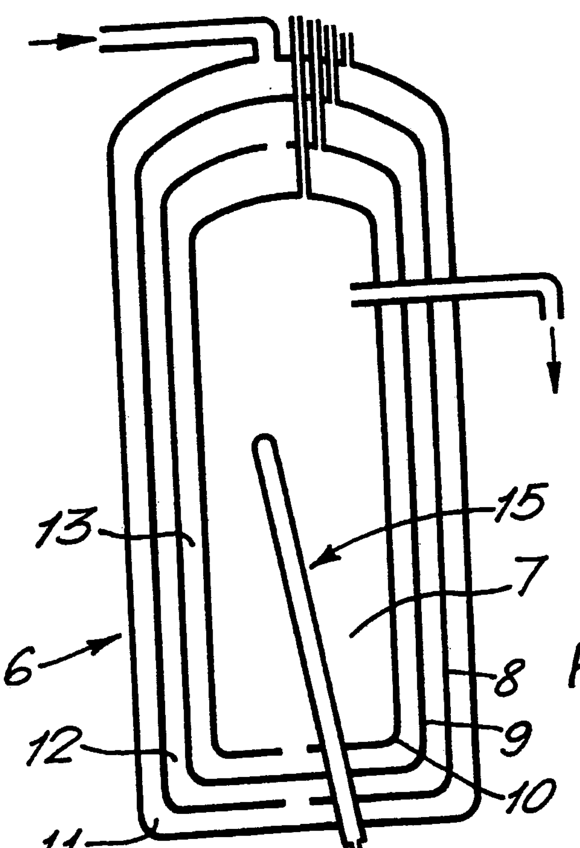


FIG.2.

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FIG.3.

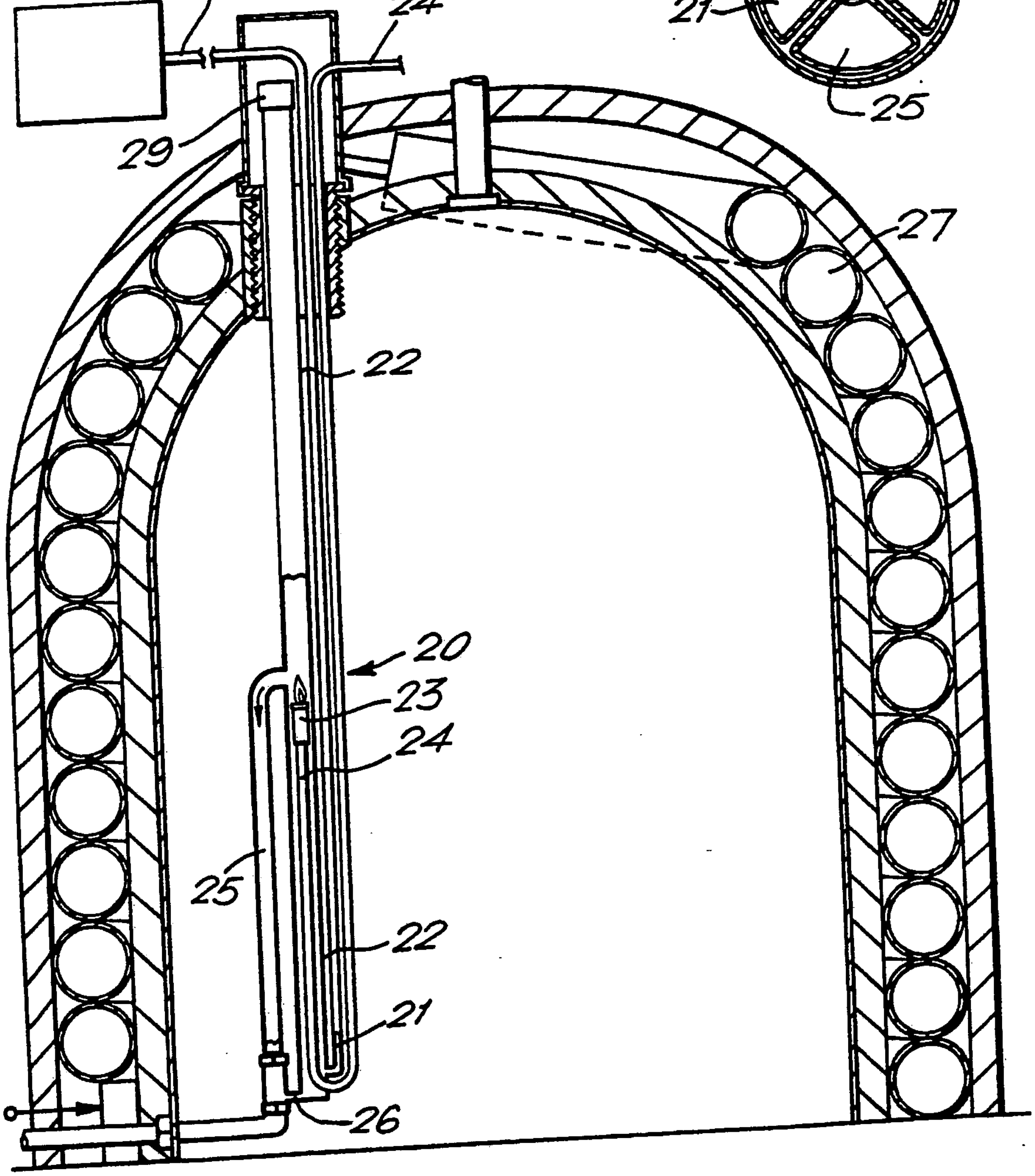
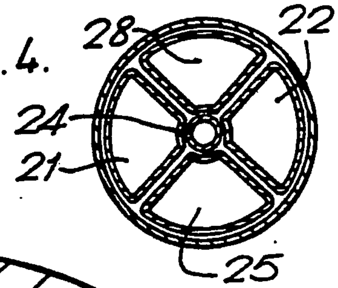


FIG.4.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 84/00450

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: ~~F 24 H 1/20~~

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC[4]	F 24 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[*]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y A	GB, A, 968970 (A.O. SMITH CORP.) 9 September 1964 see figure 1 --	1 4,7
Y	DE, A, 3204413 (BOSCH-SIEMENS HAUSGERÄTE) 18 August 1983 see abstract --	1
A	GB, A, 2070744 (FRANCESCO) 9 September 1981 see abstract --	1,2
A	FR, A, 965609 (VIDALENQ) 18 September 1950 see abstract --	1
A	DE, A, 1939898 (GAZ DE FRANCE) 6 August 1970 see page 6, paragraph 2; page 8, paragraph 1; figures ------	1,4,8

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
4th April 1985	25 AVR. 1985
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 8400450 (SA 8617)

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 968970		None		
DE-A- 3204413	18/08/83	None		
GB-A- 2070744	09/09/81	None		
FR-A- 965609		None		
DE-A- 1939898	06/08/70	NL-A-	6911739	11/02/70
		FR-A-	1582232	26/09/69
		US-A-	3580224	25/05/71
		GB-A-	1277106	07/06/72
		BE-A-	737103	05/02/70
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